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(54) Credit card

(57) This invention relates to portable devices in which information may be stored and in which the said information may be amended or updated e.g. by a transcriber. The portable credit device has formed thereon a pattern comprising individual segments each of which can be activated by an externally applied signal to give a visible and persistent display of information which remains visible in the absence of the said signal and each of which can be deactivated to erase the said visible display also by means of an externally applied signal. The visible display may be provided by electrochromic cells, liquid crystal devices, LEDs. The device may be read optically, spectrophotometrically or by electrically securing which segments are activated. A keying means may be provided for restricting access. Supplementary information may be recorded on a magnetic strip. Possible uses are at petrol filling stations, public transport and similar payment related services.

## SPECIFICATION

### Memory device

5 This invention relates to portable devices enabling a customer to acquire or to gain rapid access to goods and services, more particularly it relates to such devices in which information may be stored and in which the said information may be amended or updated. 5

Electronic methods of payment at the point of sale are known. For example, one known method allows customers to pay for petrol at six filling stations in the Norwich area using an electronic card reader which automatically records details, such as account number, stored on a magnetic stripe on one face of a credit 10 card or bank card carried by the customer. The method automatically debits a customer's bank or credit card account, issues a receipt and, at the same time, the appropriate account file stored at the bank or credit organisation as well as at the oil company's accounting centres for the filling station concerned are updated. 10

In this known method, however, it is necessary for the filling station attendant to take the card from the customer, pass it through a reader and the customer is required to sign a receipt verifying the sale. The 15 attendant, is also required to verify the signature. The method thus uses an electronic transfer of account information but it is dependent upon the customer providing verifiable signature and having a credit account recognised by the sales organisation. Point of sale use of such a credit facility may thus lead to an unacceptable delay in operation, particularly when a number of people are waiting to be served. For example, 20 in addition to the delay occasioned by a queue at a petrol filling station, rail users not infrequently experience delays occasioned by user of a credit card in the purchase of a railway ticket, and, even when a magnetic reader is used, such delays may cause the passenger or subsequent passengers to miss a train. 20

One object of the present invention is to enable a customer to gain immediate access to goods, currency or services and to debit the customer with the correct charge without delay, without the need for tendering 25 currency notes and coins and without the need for change to be given. In the remainder of this specification "a point of transaction" is used to include the beginning or the end of a journey or any point where goods or services are normally paid for, or at a mechanical device such as cash dispensing machine and the term "goods" is used to include any tangible or intangible item of value including articles of manufacture, food, natural products, currency and access to transportation or to premises or areas otherwise restricted. 25

30 According to one aspect of the present invention a device comprises a conveniently portable unit, such as a card which has formed thereon a pattern comprising individual segments each of which can be activated by an externally applied signal to give a visible and persistent display of information which remains visible in the absence of the said signal and each of which can be deactivated to erase the said visible display also by means of an externally applied signal. 30

35 In a preferred embodiment of the invention the said device has electrical connections to each individual segment for applying the said external signals thereto and each individual segment of the pattern formed on the card comprises an electrochromic cell. 35

According to a second aspect, the invention also includes a control system comprising:

(a) a card carrying information at least a part of which is visually displayed; 40  
(b) a reader unit for reading and transmitting the information carried by the card;  
(c) a processor for receiving the transmitted information from the reader unit, processing the information received (optionally in conjunction with information stored by or available to the processor) and transmitting information resulting from the processing to 40

(d) a transcriber unit which receives the transmitted information and correspondingly amends the 45 information carried on the card. 45

Information is recorded on the card at least in part by means of a visual display and is capable of amendment or modification by an external signal applied by the transcriber unit and may be magnetic, electronic, optical chemical or electrochemical in nature. A combination of these methods of storage enables a parity check to be used in order to verify the information stored.

50 The reader unit may read the information carried by the card optically by means for optical character recognition, spectrophotometrically, or electrically by electrically sensing which segments of the pattern are activated and which are deactivated. Reading is preferably carried out by electrical sensing. Preferably also the reader unit (b) is physically combined with the transcriber unit (d) to form a single reader/transcriber unit. The card is placed in the reader/transcriber unit, it is read, the information is processed in the processor and 55 the information carried by the card is then amended by applied signal from the transcribing part of the reader/transcriber unit. 55

The applied signal from the transcriber unit may be electrical, erasing the old information in appropriate segments by current reversal and inserting new information by activating (passage of current) other appropriate segments of the display. The applied signal may be magnetic and would insert new coded 60 information on the magnetic strip part of the card. The applied signal may be optical by means of a laser impinging directly into a liquid crystal cell to give an opaque or smectic form of the liquid crystal by heating or irradiation. With liquid crystal display (LCD) the applied signal may also be electric where the opacity of the liquid is sensitive to the electric field applied. In some forms the LCD may act as an unpowered memory until erasure by field reversal or by fading after a minimum period. 60

Other LCDs which may be used in this invention are described in United States Patents 3796999 and 65

4240712. In USP 4240712 the device is activated by thermo-optically in a layer of material exhibiting a smectic mesophase. In USP 3796999 a liquid crystal device can be activated and erased by localised thermal heating utilizing for example an infrared laser.

The present invention may be used for carrying out or monitoring any financial transaction including recording a balance, purchase of goods or services, payment of accounts and recording stock or availability thereof. Information in connection with recording stock or availability thereof, would naturally be available to the processor (c) and, in such a case, the card could be a stock card which is updated immediately any stock is sold.

The invention therefore includes a portable device (e.g. a card) enabling the holder to acquire goods comprises means providing a visual display of information (e.g. figures or symbols) indicating a value and means for electronic connection of the said display at a point of transaction with a reader/transcriber unit for processing of the information by the capacity to sense the value of the existing display and to replace it with a new display having a lower value such that the difference is equal to the value of the goods acquired.

The information may be in any readable form, for example, figures or symbols.

The reader/transcriber unit may comprise means for electronic connection to a portable device (a card) comprising a visual display in figures or symbols indicating a value, means for sensing the value of the display in a device connected to it, means for deducting the value of goods acquired by the holder of the portable device from the value indicated thereon and means for replacing the said visual display by a new display having a lower value such that the difference in value between the old and the new displays is equal to the value of the goods acquired.

Further design features in the devices according to the present invention may be included in their construction enabling them to perform in a more sophisticated manner. For example a magnetic strip may also be included providing a supplementary source of information for the reader/transcriber unit and a keying means may also be incorporated restricting access to only those devices having a key of the appropriate shape or size. Supplementary information could include a record of transactions or the most recent transactions thus enabling a processing error to be corrected.

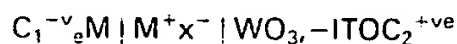
The visible display in devices according to the present invention is provided for example by liquid crystal devices, light emitting diodes or electrochromic cells. Preferably but not essentially the device providing the visual information should have the ability to remain visible, visible coloured or opaque without this passage of a current. The colour or opacity is also preferably only removed by current reversal. Light emitting diodes which, of course, do not comply with this preferred requirement may still be used where it is acceptable for the portable unit to be powered. In the case of an electrochromic cell the established pattern and will not be erased without current reversal. The established pattern thus acts both as visual and electronic memories which do not require power for their maintenance. Thus they are preferred.

Cathodic coloration of electrochromic materials and electrochromic cells suitable for providing the visual displays which may be utilized in this invention are reviewed in "Displays" January 1982 pages 3-22 (Dautremont-Smith).

A passive thin film display based on the electrochemically reversible formation of a tungsten bronze according to the reaction:



where  $0 < x < 1$  is described in an article by Green, Smith and Weiner in "Thin Solid Films" Vol. 38 (1976) pps 89-100. A thin film of  $\text{WO}_3$  may be part of a transparent sandwich in an electrochemical cell that can be coloured. e.g.



$\text{C}_1$  and  $\text{C}_2$  are metal contacts. ITO (indium-tin oxide) is a transparent conducting material and  $\text{M}^+\text{x}^-$  is an electrolyte with metal cations. Suitable cations are those of the alkali metals Li, Na and K, but others may be used.

The passage of a small amount of current through the  $\text{WO}_3$  cathode causes it to become deep blue because of the formation of a tungsten bronze (see equation (I) where  $0 < x < 0.3$ ). The electrode remains blue on open circuit and is bleached (i.e. reaction (I) is reversed) on current reversal. In such a cell a standing voltage exists owing to the M activity difference and this may be detected externally. The information displayed visually may therefore also be sensed electrically by an electronic reader unit.

Alternatively, but less preferred optical character recognition on spectrophotometric measurement may be used to access the information displayed. As indicated current reversal removes the colour of the electrochromic display and removal of the colour (sometimes referred to as bleaching) may be measured or read by comparison against a standard or comparative electrochromic display cell. Such measurement may

be achieved using spectrometer in conjunction with a photomultiplier. Where it is required to measure a particular wavelength of radiation, a monochromator may be used. Colour changes of the electrochromic display may also be detected by scanning techniques and by use of photocells.

If a white reflector is placed behind the transparent sandwich in the electrochromic cell described above, the perceived change in colour is blue to white. A letter in "Thin Solid Films" volume 40 (1977) L19-L21 describes a cell in which M- $\beta$  alumina is incorporated into the cell (where M is Li, Na or K):



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Japanese patent publication 7909170 23rd January 1979 (Application 77/73856 23 June 1977) describes silver containing  $\beta$ -alumina in which  $Ag^+$  are the colour inducing ions.

The present invention also includes a process for the purchase of goods comprising:

- 15 a) issuing to the customer in exchange for cash or credit a portable device (e.g. a card) as described herein into which device a nominal value is entered and is capable of display to the customer: 15
- b) accepting said device from the customer at a point of transaction and processing same by use of a reader/transcriber unit according to the second aspect of the present invention; and
- 20 c) returning the said device to the customer with value of the display reduced by an amount equal to the value of the goods purchased. 20

At stage (b) acceptance of the said device from the customer may simply entail giving the customer direct access to the reader/transcriber unit. In the case of transportation by railway, road vehicle or airplane, for example, the device may need to be processed both at the start and the end of the journey. The first processing would insert information in the device regarding place of commencement of journey and the second processing would use the information to deduct the appropriate value. In another example the first processor would insert information as to time of commencement where payment is to be related to time of use of a service such as vehicle hire, car-parking, hotel accommodation and similar services.

The value displayed by the device according to the first aspect of the present invention may be alpha-numeric or may be symbolic. Numerals may express a sum in any currency, e.g. pounds sterling or dollars, which may be arithmetically reduced in value by the reader/transcriber on purchase of further goods or symbols or letters may simply be erased by the reader/transcriber so that the device will expire when all symbols or letters in the display have been erased. The device will then be ready for recharging by the issuing authority in exchange for more credit or cash from the customer holding the device.

The device has the advantage of being directly readable by sales personnel or inspectors who can then immediately sanction its use as a credit instrument. A device whose value had been completely exhausted or reduced below the value of the goods to be acquired, or an out of date device, could be rejected by the reader/transcriber without further processing or if desired the reader/transcriber could enter and accept a certain overdrawn or negative value on the display. A rejection could be accompanied by visible or audible warning to the attendant if required.

The reader/transcriber units according to the present invention would normally incorporate programmable machine intelligence at the appropriate level for the degree of sophistication that its operation required.

The multiple connections of the normal seven bar symbol alpha-numeric visible display each need to be sensed by the reader/transcriber to enable the current value of the device to be read. The new value may then be inserted by applying potential to the terminals necessary and erasing the previous display where necessary by current reversal. A magnetic reader may also be incorporated as well as electronic sensing to detect more of the information held in the portable device for the time being connected to it.

Micro processing means would enable the reader/transcriber unit to be compact thus enabling several units to be positioned in a relatively restricted area. Reader/transcribers could be incorporated into automatic ticket gates currently in use by some transport authorities.

In yet a further embodiment the electrochromic display could duplicate information also contained in magnetic form in the device.

#### CLAIMS

1. A portable credit device having formed thereon a pattern comprising individual segments each of which can be activated by an externally applied signal to give a visible and persistent display of information which remains visible in the absence of the said signal and each of which can be deactivated to erase the said visible display also by means of an externally applied signal.

2. A device according to claim 1 which has electrical connections to each individual segment for applying the said external signals.

3. A device according to claim 1 in which information is recorded on the device by one or more magnetic, electrical, optical, chemical or electrochemical means.

4. A device according to claim 3 in which the information is recorded by a liquid crystal display.

5. A device according to claim 3 in which the information is recorded by a light emitting diode display.

6. A device according to claim 3 in which the information is recorded by an electrochromic cell display.

7. A device according to claim 6 in which the electrochromic cell contains a transition metal oxide which colours cathodically by a reduction process.
8. A device according to claim 6 in which the electrochromic cell contains a transition metal oxide which colours anodically by an oxidation process.
- 5 9. A device according to claim 7 in which the transition metal oxide is selected from the group comprising of W, Mo, V, Nb, and Ti. 5
10. A device according to claim 8 in which the transition metal oxide is selected from the group comprising oxides of Ir, Rh, Ni and Co.
11. A device according to claim 6 in which one or more of the electrochromic cells contain a solid electrolyte. 10
12. A device according to claim 11 in which the solid electrolyte is  $\beta$ -alumina.
13. A device according to claim 7 in which the cathodic colouration occurs by insertion of an cation selected from the group comprising H, Li, Na, K and Ag.
14. A device according to claim 4 or on 5 in which the information is entered or erased by means of an externally applied signal used to produce interruption of an electrical field. 15
15. A device according to claim 6 in which the information is entered or erased by means of an externally applied signal used to produce electrical current reversal. 15
16. A device according to claim 3 in which the information recorded by the liquid crystal display is written thermo-optically in a layer of material exhibiting a smetic meso-phase.
- 20 17. A device according to claim 3 in which the information recorded by the liquid crystal display is written and erased by heating. 20
18. A device according to claim 17 in which the heating is provided by laser.
19. A device according to any preceding claim which is in the form of a card.
20. A control system comprising:
- 25 a) a portable credit device carrying information at least a part of which is visually displayed, 25
- b) a reader unit for reading and transmitting information carried by the portable credit device,
- c) a processor for receiving the transmitted information from the reader unit, processing information received (optionally in conjunction with information stored by or available to the processor) and transmitting information resulting from the pressing processing to
- 30 d) a transcriber unit which receives the transmitted information and correspondingly amends at least some of the information carried on the portable credit device. 30
21. A control system according to claim 20 in which the portable credit device is according to any one of claims 1 - 19.
22. A control system according to claim 20 in which the reader unit operates by optical, spectrophotometric or electrical sensing means. 35
23. A control system according to claim 20 in which the reader unit and transcriber unit are combined into a single reader/transcriber unit.
24. A control system according to claim 20 in which the transcriber unit operates by optical, spectrophotometric on electrical means to amend information carried on the portable credit device.
- 40 25. A process for the purchase of goods comprising: 40
- a) issuing to the customer in exchange for cash or credit a portable credit device according to claim 1 into which device a nominal value is entered such that the said value is shown as a visible display in alphabetical, numerical or symbolic form,
- b) accepting said device from the customer at a point of transaction and processing same by use of a control system according to claim 20, and 45
- c) returning the said device to the customer with the visible display of value reduced by an amount equal to the value of goods purchased.

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